Aerosol Transmission of Infectious Disease

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Objective: The concept of aerosol transmission is developed to resolve limitations in conventional definitions of airborne and droplet transmission. **Methods:** The method was literature review. **Results:** An infectious aerosol is a collection of pathogen-laden particles in air. Aerosol particles may deposit onto or be inhaled by a susceptible person. Aerosol transmission is biologically plausible when infectious aerosols are generated by or from an infectious person, the pathogen remains viable in the environment for some period of time, and the target tissues in which the pathogen initiates infection are accessible to the aerosol. Biological plausibility of aerosol transmission is evaluated for Severe Acute Respiratory Syndrome coronavirus and norovirus and discussed for *Mycobacterium tuberculosis*, influenza, and Ebola virus. **Conclusions:** Aerosol transmission reflects a modern understanding of aerosol science and allows physically appropriate explanation and intervention selection for infectious diseases.

Conventionally, infectious disease transmission is classified into three routes—airborne, contact, and droplet—and unique infection control procedures and personal protective equipment are recommended for each route.[1] Airborne transmission is defined as resulting from the inhalation of small particles, often termed droplet nuclei and considered to have diameters 5 μm or less. Importantly, the description offered by the Healthcare Infection Control Practices Advisory Committee (HICPAC) implies that susceptible people become infected through airborne transmission only when at some, relatively long, distance from the infectious source.[1] Contact transmission may be direct or indirect. In direct contact, the pathogen is transferred from an infectious person to a susceptible person directly, whereas in indirect contact the pathogen moves to the susceptible person by way of another object, like a contaminated surface. Droplet transmission is a type of direct contact involving droplets emitted from the respiratory tract of an infectious person, generally considered to be larger than 5 μm in diameter, that travel directly to the facial mucosa of a susceptible person—that is, the droplets are propelled a short distance from an infectious source.

A key limitation in the definitions of airborne and droplet transmission routes arises from the dichotomy drawn with respect to particle size and distance—small particles are inhaled by a susceptible person some distance from the source (airborne transmission), whereas large particles project onto the facial mucosa of a susceptible person proximal to the source (droplet transmission). These definitions arose from early work in tuberculosis transmission (such as Wells[2]), when sampling methods were unable to measure particles suspended in air in the vicinity of an infectious source. Since that time, aerosols generated from the respiratory tract by talking, cough, and sneeze have been demonstrated to contain both sub- and supermicrometer particles.[3] And, our understanding of the inhalation and deposition of particles in the respiratory tract has also improved[4]—particles as large as 100 μm can be inhaled and deposited in the respiratory tract (Table 1).

The HICPAC has recognized limitations in the current paradigm of airborne and droplet disease transmission.[1] For example, the committee discusses the idea that droplets may pose a risk to workers more than 3 feet from an infectious patient.[1(pS79)] And, the committee notes that some viruses capable of causing respiratory and gastrointestinal infections may be transmitted by *small-particle aerosol* in addition to the primary droplet and contact routes, respectively.[1(pS79)] Small-particle aerosol, however, is not defined relative to the three conventional transmission routes.

To address these limitations, we propose the concept of *aerosol transmission*. Previously, we introduced the concept of aerosol transmission in general and with respect to Ebola virus disease (EVD) owing to concerns about high rates of infection and mortality among health care workers in the current West African EVD outbreaks.[5,6] Here, we further develop the idea of the aerosol transmission route and apply the concept to several pathogens. Specifically, we consider aspects of a pathogen that make aerosol transmission biologically plausible. Although biologically plausible, aerosol transmission may be an opportunistic route for some pathogens, such as in the context of laboratory settings.[7] Roy and Milton[8] characterized an opportunistic transmission route as involving a novel source or unorthodox transmission pattern, but transmission through opportunistic routes need not be rare.

AEROSOL TRANSMISSION

An aerosol is a collection of solid or liquid particles suspended in a gas, such as air.[4] An aerosol may contain particles of any size. The fate of an aerosol in the environment is governed by physical processes. Gravitational force will accelerate particles toward the ground—in still air, the settling velocity is proportional to the square of the particle diameter,[4] such that larger particles will settle from air more rapidly than smaller particles (Fig. 1). The movement of air, both turbulent and advective, transports an aerosol through space and may slow the rate of particle gravitational settling. Transport of particles by turbulence and advection is much faster than molecular-scale diffusion, though the latter process also occurs.

In the context of infectious disease transmission, many bodily processes and medical procedures generate aerosols, and the aerosol particles may contain pathogens in conjunction with body fluids.[9–12] The range of particle sizes in an infectious aerosol depends on a number of factors including, but not limited to, the mechanism of aerosol generation and the liquid content and viscosity of the aerosolized fluid.[13] The liquid content of the particle influences the extent to which the particle size reduces with evaporation, although evaporation occurs rapidly, within a second of aerosol generation.[3] Aerosols generated from infectious people are subject to the same transport processes that govern other aerosols.

Cough and sneeze are prototypical bodily processes that generate aerosols. Studies of aerosols generated by cough and sneeze have been shown to include particles that vary over several orders of magnitude[14–18] and contain pathogens.[19–22] Figure 1(a) illustrates an aerosol plume, such as might be emitted by a cough. Circles of three sizes represent particles of different sizes. A person standing in the plume may have particles impact onto his or her facial mucosa but will also inhale particles. Larger inhaled particles will deposit in the head airway or trachea-bronchial regions of the respiratory

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TABLE 1. Percentage of Particles That Are Inhaled and Deposit in Different Regions of the Respiratory Tract by Particle Aerodynamic Diameter, Based on Simplified Equations for the International Commission for Radiological Protection Model[4]

	Percentage of Particles Inhaled and Deposited Particle Aerodynamic Diameter			
Respiratory Tract Region	**0.1 μm**	**1 μm**	**10 μm**	**100 μm**
Head airways	2.1	29	81	50
Tracheobronchial	2.7	2.7	1.5	<0.1
Alveolar	14	12	1.9	<0.1

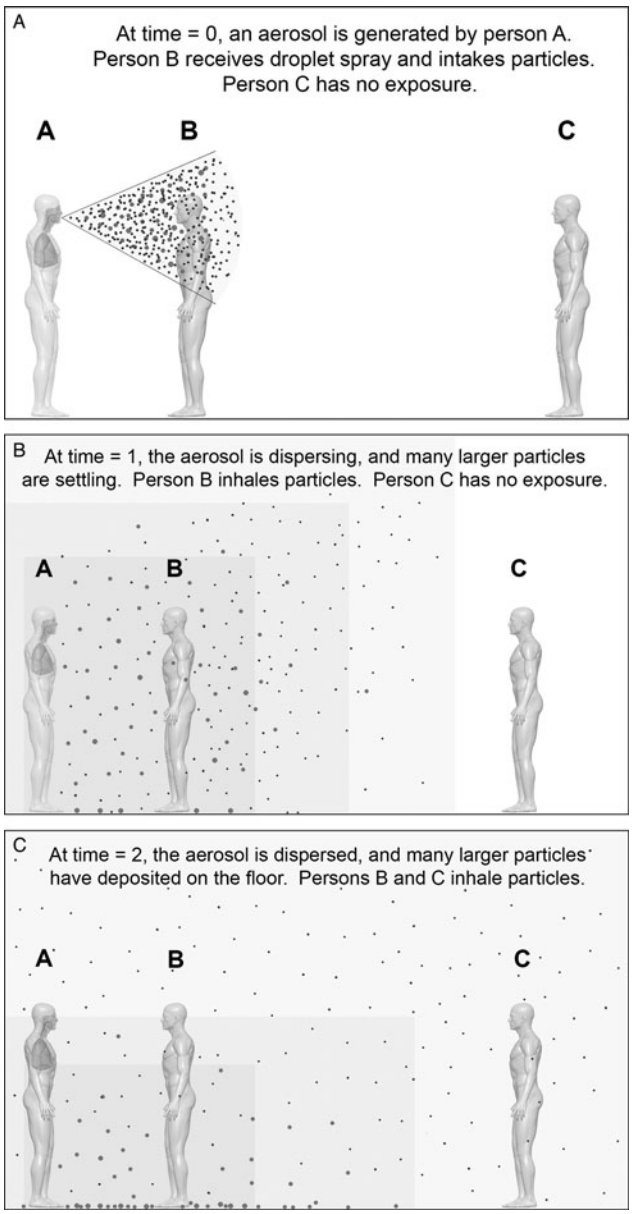

FIGURE 1. Schematic of aerosol emission and dispersion over time. Made by Carlyn Iverson, used with permission from the Center for Infectious Disease Research and Policy.

tract, whereas smaller particles will primarily deposit in the alveoli (Table 1).[4]

The fate of aerosol particles in the environment over time is shown in Figs. 1(b) and 1(c)—larger particles move toward the floor more rapidly due to gravitational force and travel shorter lateral distances than smaller particles. Ultimately, some particles may be dispersed throughout the environment and travel far enough that a person remote from the source (eg, at location C) may inhale them. Figure 1 is designed to reflect these processes in general terms, but measurement data and modeling, including computational fluid dynamics simulation, can demonstrate the length and time scales of particle size-specific processes in a particular environment.

The dose of pathogens received by susceptible people at locations B and C in Fig. 1 depends on a number of factors, including the number of pathogens present in aerosol particles of different sizes, pathogen survivability (influenced by temperature, relative humidity, suspension medium, and other factors), surface area of facial mucosa or skin exposed, breathing rate, and other factors. The generation of an aerosol by an infectious person may not always result in exposure to pathogens among bystanders.[23]

Aerosol transmission may occur among pathogens that cause infections in parts of the body other than the respiratory tract. The respiratory tract may serve as a portal of entry to the gastrointestinal tract,[24,25] or pathogens in the respiratory tract may overtake and subvert immune cells and processes resulting in dissemination throughout the body.[26,27] Pathogens may deposit onto skin and penetrate the skin through abrasions and cuts. And, respiratory pathogens may reach the respiratory tract through other portals, such as the eyes.[28,29]

ESTABLISHING BIOLOGICAL PLAUSIBILITY

The transmission of an infectious disease among people requires that an infectious person releases the pathogen into an environment where a susceptible person can take up the pathogen into or onto his or her body. For any specific route of transmission to be biologically plausible, the pathogen must be released into the environment and survive to reach target tissue(s) in or on the susceptible person where it can interact with cellular receptors to initiate cell-entry and infection. Not all biologically plausible transmission routes occur routinely, and some may occur opportunistically in selected settings.[8] The aerosol transmission route is biologically plausible for a pathogen when (1) aerosols containing the pathogen are generated by or from an infectious person, (2) the pathogen remains viable in the environment for some period of time, and (3) the target tissues in which the pathogen initiates infection are accessible to the aerosol. We describe these conditions more specifically and illustrate their evaluation with reference to selected pathogens, for which there is varied evidence of transmission through the aerosol route.

Evidence to evaluate the biological plausibility of the aerosol transmission route for a specific pathogen may be holistic, simultaneously addressing all three conditions. That is, aerosol transmission

of the pathogen is demonstrated among people for whom other routes of exposure have been excluded; or infections are prevented by exclusion of the aerosol transmission route. Alternatively, experimental or observational epidemiologic evidence may address one or two of the three conditions (Table 2). We suggest a qualitative evaluation of the strength of evidence for aerosol transmission on the basis of the quality and quantity of data and weight of evidence for each of the three conditions. The strongest evidence for any condition would involve the actual pathogen (not a laboratory or animal-adapted strain) in experiments or observations in real-life settings and environmental conditions, and culture-based methods for quantification of pathogens and/or human exposure. Culture-based methods quantify culturable (infectious) pathogens, whereas culture-independent methods identify segments of pathogen genomes and may be less convincing of biological plausibility. Culture-based methods are not available for all pathogens, however.

Consider condition 1, that aerosols containing the pathogen are generated by or from an infectious person. Evidence consistent with this condition would include disease symptoms that cause body fluids containing pathogens to be aerosolized (in vivo or in vitro), symptoms require medical procedures that cause body fluids containing pathogens to be aerosolized (in vivo or in vitro), or pathogens are detected in aerosol generated in vivo. The first two lines of evidence contribute to a mechanistic argument for pathogen presence in aerosols, whereas the measurement of pathogens in aerosols would provide strong evidence for condition 1. Weaker pieces of evidence include sampling of surfaces on which aerosol may deposit, analogy with other pathogens, and measurement of aerosols containing pathogens generated by animal models.

Consider condition 2, that the pathogen remains viable in the environment for some period of time. Although some pathogens may be capable of multiplying in aerosol particles,[30] the more likely outcome is that pathogens lose viability at some point after aerosol generation. Laboratory-based studies of pathogen viability can demonstrate the timescale of pathogen inactivation, which, when compared with the timescales of transport and exposure, can indicate the likelihood that pathogens remain infectious until taken up by a susceptible person. The strongest evidence of pathogen survivability would involve the actual pathogen, not a laboratory strain or surrogate, aerosolized in body fluids, not culture media or on surfaces. More robust evidence would be the detection of pathogens by culture-based methods, if available, in aerosol emitted by an infectious person in air over time in a relevant environment.

Consider condition 3, that the aerosol can access target tissues. Pathogens in aerosol may impact on the skin or facial mucosa or may be inhaled; once in the body, pathogens may be transported to diverse locations. The location of target tissues can be identified through in vitro studies of tissues and cellular receptors or studies in vivo. The ability of an aerosol to reach these target tissues can be demonstrated by (in order of declining strength)—infection subsequent to aerosol exposures in humans or animal models, detection of aerosolized pathogens at the target tissue, experiments with tracers in humans or animal models, or through a mechanistic argument.

Biological plausibility of aerosol transmission does not inform the likelihood of infection occurring among susceptible people in a specific setting per se. In particular, the three conditions for biological plausibility do not specify the path taken by a pathogen from the infectious person to susceptible person. Computational fluid dynamics simulations and other models,[31,32] or measurement of pathogens in the environment, can determine a plausible path taken by a pathogen from an infectious person or environmental reservoir to a susceptible person and determine the magnitude of exposure. The likelihood of infection, subsequent to exposure, is determined by a dose–response function.

The overall weight of evidence with respect to the potential a pathogen is transmitted through the aerosol route can be tabulated

TABLE 2. Quality Ratings of Evidence for Each of the Three Conditions for Biological Plausibility of Aerosol Transmission. Numerical Score of Evidence Quality is Indicated Parenthetically

	Quality of Evidence		
Condition	**Weak (1)**	**Moderate (2)**	**Strong (3)**
1. Aerosol generation	• Pathogen present in bodily fluids • Pathogen measured on surfaces in the area of infectious source	• Infection has symptoms or requires treatment that cause bodily fluids containing pathogens to be aerosolized • Pathogens are detected in aerosols emitted by infected animal models.	• Pathogens are detected in aerosols emitted by or generated from an infectious person
2. Viability in environment	• The pathogen, surrogate, or laboratory-adapted strain using culture-based on culture-independent methods survives on surfaces at ambient conditions for hours	• The pathogen, using culture-independent methods, is present in the air at ambient conditions for hours in laboratory media or body fluids • Surrogate or laboratory-adapted strain, using culture-based methods, survives in the air at ambient conditions for hours in laboratory media or body fluids	• The pathogen, using culture-based methods if available, survives in the air at ambient conditions for hours in laboratory media or body fluids • Epidemiologic evidence of transmission through air over long distances
3. Access to target tissue	• Target tissue identified in animal models and is plausibly accessible to aerosols	• The target tissue has been identified through experimental infection in humans through nonaerosol routes or in vitro studies and is plausibly accessible to aerosols • Experimental infection demonstrated in an animal model through the aerosol route	• Experimental infection in humans has been demonstrated through the aerosol route

by assigning a numerical score to the level of evidence (weak = 1, moderate = 2, and strong = 3) for each of the three conditions for biological plausibility and summing the scores across the three conditions. The overall weight of evidence score may take on values 3 to 9, and we consider a score of 6 or more to indicate potential for aerosol transmission because it indicates moderate to strong evidence for two or more conditions. This scoring rubric was developed by the authors to provide a simple, transparent system for evaluating the quality of evidence and should be revised as new information and insights become available.

Table 3 defines concern for potential aerosol transmission to be high or low, on the basis of the overall score and the pathogen's risk group.[33] Pathogen risk group classifications, such those developed by the Centers for Disease Control and Prevention[34] and the World Health Organization[35] for laboratory biological safety, primarily consider the severity of disease, availability of treatment, and likelihood of person-to-person transmission. Concern about preventing aerosol transmission should be heightened for pathogens that cause more severe disease. As a result, risk group 4 organisms were all classified as having high concern when the overall weight of evidence score is three or more, owing to the severe consequences of infection.

EVALUATION OF SELECTED PATHOGENS

To demonstrate how one might evaluate the biological plausibility of aerosol transmission, as well as the quality of current evidence, we consider Severe Acute Respiratory Syndrome coronavirus (SARS CoV) and norovirus.

Severe Acute Respiratory Syndrome Coronavirus

Severe Acute Respiratory Syndrome CoV causes febrile respiratory infection and atypical pneumonia and is classified by HICPAC as transmitted through the droplet route.[1] Specific medical procedures that aerosolize respiratory secretions were associated with outbreaks among health care workers, including resuscitation, positive airway pressure ventilation, and endotracheal intubation.[36–41] These medical procedures also require workers to be in proximity to patients, so it is not possible to retrospectively attribute exposures to specific routes of transmission. No experimental studies in humans have demonstrated transmission of SARS by aerosol *or any other route*. Thus, we consider each of the three conditions for biological plausibility in turn.

- *Condition 1:* SARS CoV is present in respiratory secretions.[42,43] It is known that respiratory secretions can be aerosolized by cough, a symptom of SARS CoV,[44,45] and by medical procedures applied for respiratory infections and/or respiratory distress.[46–48] Severe Acute Respiratory Syndrome CoV is also in fecal material, and diarrhea is a symptom of infection.[49] Toilet flushing is known to emit aerosols.[50,51] To our knowledge, no one has attempted to measure SARS CoV emission in aerosols directly, but the virus has been measured in the environment of patients. Tsai et al[52] collected 11 air samples over 8 hours approximately 1 m from the bed of patients with SARS while they were intubated and after extubation, and all samples were polymerase chain reaction–positive for SARS CoV DNA. Booth et al[53] found 1 of 10 air samples collected in a room where a patient was recovering from SARS to be positive for SARS CoV DNA; samples collected in other patient areas were negative. Surface swab samples were more likely to be polymerase chain reaction–positive for SARS CoV in the environment around an infectious person than at remote locations.[53,54]
- *Condition 2:* Laboratory studies have shown that SARS CoV may remain viable in diarrheal stool and respiratory specimens and on smooth surfaces for several days at room temperature.[55,56] SARS CoV survival has not been tested directly in aerosols. Epidemiologic studies in conjunction with pathogen fate-and-transport models suggest that SARS CoV can survive in the environment long enough to reach susceptible persons.[31,32] Epidemiologic evidence from the Amoy Gardens outbreak indicates that SARS CoV may remain infective while in air for long enough to be transported to susceptible people.[57,58]
- *Condition 3:* Experimental studies in animals have demonstrated SARS CoV infection subsequent to intranasal instillation;[59,60] these data have been used to develop a dose–response model for use in human health risk assessment.[61] The obligate cellular receptor for SARS CoV in humans is thought to be Angiotensin Converting Enzyme 2, which is present in pneumocytes, lung epithelium progenitor cells, and other cells that overlap with SARS CoV replication sites in the lung.[62] Aerosols can be inhaled and deposited in the nasal passages and lungs (Table 1), where SARS CoV receptors are located.

TABLE 3. Level of Concern Regarding Potential for Aerosol Transmission, With Reviewed Pathogens, Which Incorporates Plausibility of Aerosol Transmission (Weight of Evidence) With Consequences of Infection (Risk Group). High Concern Indicated by Dark Gray and Low Concern by Light Gray

Weight of Evidence	Risk Group 1	2	3	4
9				
8		Influenza	Tuberculosis	
7		Norovirus	Severe Acute Respiratory Syndrome	Ebola
6				
5				
4				
3				

Weight of Evidence for Aerosol Transmission

Comparing this literature review with the criteria in Table 2 indicates that the evidence for conditions 1 and 3 is moderate and for condition 2 is strong. This gives an overall weight of evidence score of 7. Because SARS CoV is a risk group 3 pathogen, Table 3 indicates a high level of concern with respect to the aerosol transmission of SARS CoV.

Noroviruses

Noroviruses cause gastroenteritis. The HICPAC[1] discusses the potential role of *small-particle aerosols* in the transmission of noroviruses on the basis of epidemiologic evidence that susceptible people develop infection when remote from the infectious person (eg,[63,64]) but recommends contact precautions, which interrupt only the contact transmission route. Experimental studies have demonstrated norovirus infection in humans subsequent to ingestion,[65,66] but other routes have not been tested to our knowledge. Thus, we consider each of the three conditions for biological plausibility in turn.

- *Condition 1:* Norovirus is present in vomitus[67–69] and feces;[70,71] vomiting and diarrhea are symptoms of norovirus infection. The characteristics of vomiting are not well understood, although Makison Booth[11] has developed a simulated vomiting system in which vomitus is aerosolized. As previously noted, toilet flushing emits aerosols.[50,51] Air sampling for norovirus, to our knowledge, has not identified norovirus but was confined to settings without known norovirus infections.[72,73] The presence of norovirus on

surfaces during outbreaks in health care and other settings has been well documented using culture-independent methods.[74–76] Surface contamination with pathogens may occur through contact with other contaminated objects[77] or deposition of aerosolized pathogens.

- *Condition 2:* Norovirus surrogates have been shown to survive for days to weeks on glass at low relative humidity (10% to 35%) and for hours at high relative humidity (55% to 85%).[78] Similarly, Norwalk virus, a prototypical norovirus, survived for days on stainless steel, formica, and ceramic when applied in suspension, but purified Norwalk RNA was not detectable on stainless steel after 24 hours.[79] To our knowledge, the survival of norovirus has not been measured in air. Norovirus infections in outbreaks have been documented to occur among susceptible people remote from the emission source, where contact with norovirus-contaminated surfaces was unlikely to occur,[63,64,80] suggesting that norovirus can survive for some time in air.
- *Condition 3:* Experimental studies have demonstrated norovirus infection in humans subsequent to ingestion,[65,66] but aerosol exposure has not been studied. In mice, however, transport of material to the gastrointestinal tract has been demonstrated subsequent to intranasal instillation.[24,25] Continuity of the respiratory and gastrointestinal tracts is also present in humans, suggesting that inhalation of norovirus or spray of norovirus onto the facial membranes could result in exposure to the gastrointestinal tract. In addition, norovirus may be sprayed or inhaled into the mouth and swallowed.

Weight of Evidence for Aerosol Transmission

Comparing this literature review with the criteria in Table 2 indicates that the evidence for conditions 1 and 3 is moderate and for condition 2 is strong. The overall weight of evidence for aerosol transmission of noroviruses is 7. Noroviruses are considered a risk group 2 pathogen, so Table 3 indicates that there should be a high level of concern regarding aerosol transmission of this class of organisms.

DISCUSSION

The objective of this work was to develop the concept of aerosol transmission of infectious diseases, with the intent of moving from the artificially dichotomized airborne and droplet transmission routes toward a more physically appropriate representation of the exposure and infection process. From our perspective, the concept of aerosol transmission is of primary importance to occupational health and will enable physically accurate communication about exposure and intervention selection. In particular, recognizing a pathogen as having the potential to be transmitted through the aerosol route should trigger consideration for controls, such as respiratory protection, that limit workers' exposures when in proximity to infectious patients, regardless of evidence for airborne transmission. A risk-assessment approach, such as described by McCullough and Brosseau,[81] is recommended to identify conditions in which respiratory protection should be used.

Only respiratory protection effectively prevents the inhalation of aerosol particles, surgical masks do not meet National Institute for Occupational Safety and Health or Occupational Safety and Health Administration criteria for respiratory protection. There has been widespread resistance to the use of respiratory protection among health care workers and infection control professionals, necessitating clinical trials to evaluate the relative effectiveness of respirators and surgical masks,[82,83] despite evidence that respirators have better filtration and fit.[84,85] Most health care facilities currently have respiratory protection programs, including respirator fit testing,[86–88] which suggests that replacement of surgical masks with N95 filtering facepiece respirators will not be onerous.

We selected two pathogens with which to demonstrate how to evaluate the biological plausibility of aerosol transmission—SARS CoV and noroviruses, but a number of other agents are transmitted through the aerosol route. *Mycobacterium tuberculosis* is currently recognized as transmitted through the airborne route[1] and would also be classified as transmitted through the aerosol route. Specifically, viable *M. tuberculosis* bacilli are emitted in cough,[89] the bacilli survive in air over tens of minutes,[90] and infection of animals by bacilli carried in air from tuberculosis hospital wards has been demonstrated experimentally,[91] which are strong, strong, and moderate levels of evidence for conditions 1 to 3, respectively (Table 2). As a risk group 3 organism with an overall weight of evidence score equal to 8, there should be a high level of concern for aerosol transmission as a route of exposure (Table 3). This is supported by the current Centers for Disease Control and Prevention guidance for managing tuberculosis patients in health care settings.[92]

Although there has been debate about whether influenza is transmitted through the airborne route, it is clearly transmitted through aerosols. Specifically, virus is emitted in aerosols from infectious people,[12] virus is present in the air around infectious people,[9,93] and infection has been demonstrated in human subjects subsequent to virus inhalation and intranasal instillation,[94,95] which are strong, moderate, and strong levels of evidence for conditions 1 to 3, respectively (Table 2). Seasonal influenza is a risk group 2 organism; novel influenza is in risk group 3. With an overall weight of evidence score equal to 8, either risk group designation indicates that there should be a high level of concern about aerosol transmission of influenza (Table 3).

Previously,[5,6] we argued that aerosol transmission of Ebola virus was biologically plausible. With respect to condition 1, Ebola virus is present in saliva, stool, feces, blood, and other body fluids[96,97] that can be aerosolized through symptoms of EVD and through health care delivery. With respect to condition 2, Ebola virus survives in the air for tens of minutes.[98] And with respect to condition 3, Ebola virus initiates infection in diverse target tissues including cells present in the respiratory tract,[26,27] and infection has been demonstrated in guinea pigs subsequent to intranasal and aerosol exposure.[99,100] With reference to Table 2, the quality of this evidence is moderate, strong, and moderate for conditions 1 to 3, respectively. With an overall weight of evidence equal to 8 and a risk group assignment of 4, a high level of concern for aerosol transmission of Ebola virus is clearly appropriate.

One concern that arises in the context of aerosol transmission and Ebola virus is the distance over which the disease can be transmitted—is it airborne, as in the classical definition of airborne transmission? In the context of EVD, epidemiologic evidence is not consistent with high risk (observable) of transmission from infectious people to remote susceptible people—that is, transmission risk is increased with direct physical contact or contact with body fluids.[101–103] The absence of remote infection does not mean aerosol (or airborne) transmission is impossible; it may be improbable or occur simultaneously with contact. From a physical perspective, possible explanations for lack of remote transmission include exposure to low doses of Ebola virus at remote locations owing to low virus emission to air or rapid loss of infectivity or low infectivity of Ebola virus. This issue reflects a broader challenge in public health—explaining complex, uncertain, and variable phenomena to the public. In our discussions about aerosol transmission of EVD, we have not found the lack of specificity about distance to contribute to confusion. In fact, we have found that discussion of epidemiologic, microbiologic, and physical evidence to be persuasive that the greatest risk occurs with proximity, which is a general principle applicable to all pathogens emitted from a point source.

The evaluation of the quality of evidence for biological plausibility of aerosol transmission (Table 2) and the classification of aerosol transmission as having low or high concern (Table 3)

were based on our review of the literature and professional judgment. Alternative classifications are possible, and we hope that the classifications developed herein stimulate debate in the occupational health and infection control communities. Future work will seek to identify specific work places and work practices in which aerosol transmission is more likely to occur so that risk assessments and exposure controls can be more efficiently targeted.

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